STANDARD

PROCEDURE

G-6030 b)

PROGRAM: Standard Work Aids

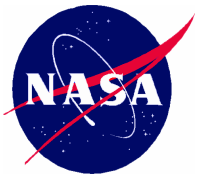
PROJECT: Cost Estimating Tasks

SUBJECT: Life Cycle Cost – Background and Overview

Authorized by: _____
Charlotte Y. diCenzo, Cost Accounting (CFG) Branch Chief

Dated on _____

Total Pages 17



[i]AMES Research Center
Moffett Field, Ca 94035-1000

SUBJECT: Life Cycle Cost

Date: 22 January 2002

Prepared For: Lewis Braxton, CFO

BACKGROUND:

> "...[T]he Administration will attempt to integrate more completely information about costs and programs performance in a single oversight process. This would include ***budgeting for the full cost of resources where they are used***, making budget program and activity lines more parallel with outputs, and, where useful, improving alignment of budget accounts."
>
> The President's Management Agenda

FY 2001 Authorization Bill; Requirement for an Independent Cost Estimate:

(a) REQUIREMENT: --Before any funds may be obligated for Phase B of a project that is projected to cost more the $150,000,000 in *total projects costs*, the Chief Financial Officer for NASA shall conduct an independent life-cycle cost analysis of such project and shall report the results to Congress.
(b) DEFINITION: For purposes of this section, the term "Phase B" means the latter stages of project formulation, during which the final definition of a project is carried out and before project implementation (which includes Design, Development, and Operations Phases) begins.

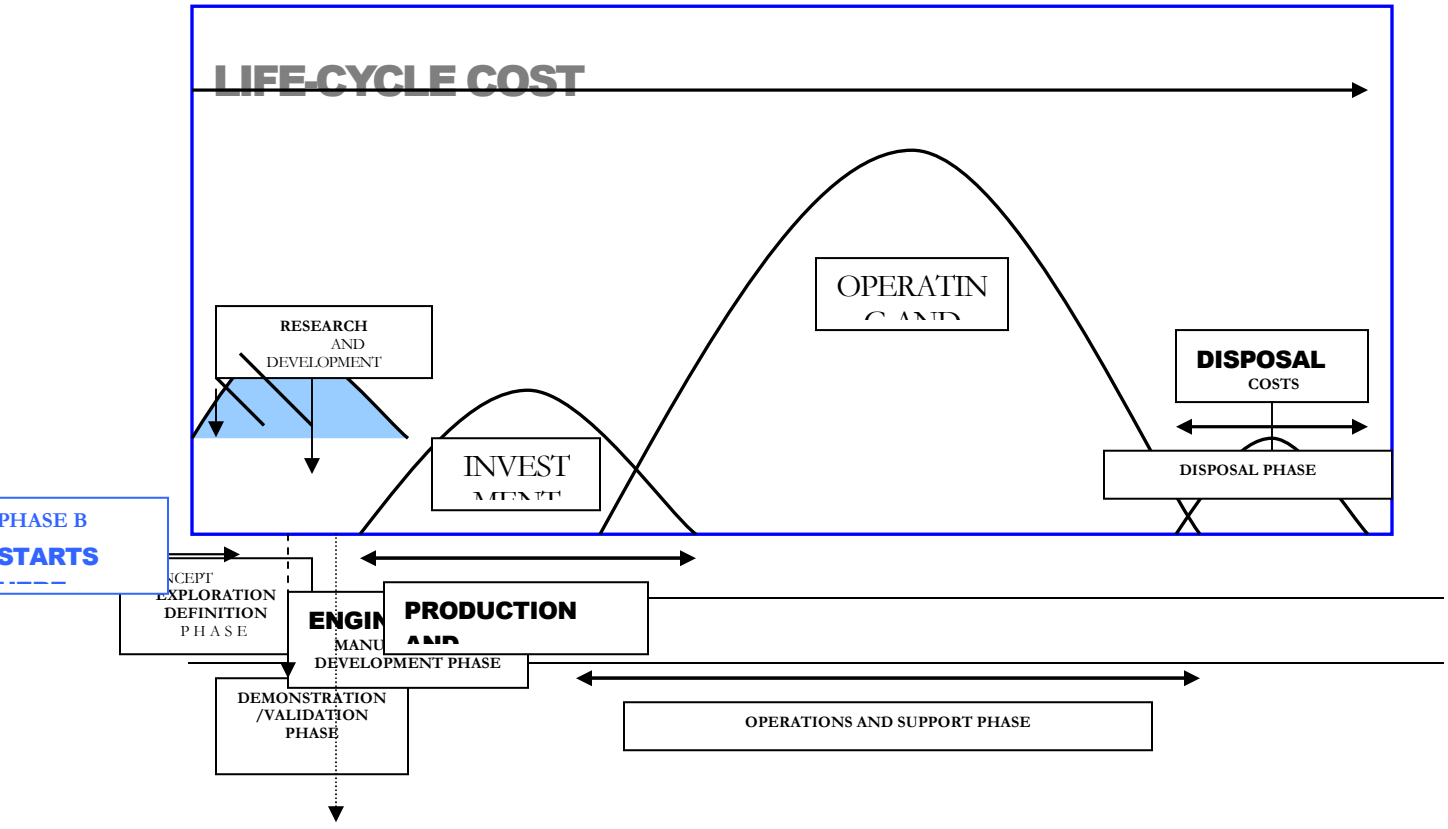
NASA's decision to fund a new program requires a commitment to support that program years into the future. These decisions are based upon many factors, one of which is the projected cost of the program over its operational lifetime. The credibility of NASA with Congress and the American taxpayer begins with a reasonable and fully documented estimate and basis thereto for the complete life-cycle cost of the program. Step one in preparing this estimate is the determination of what is included in life-cycle cost.

OVERVIEW OF THE ELEMENTS OF LIFE-CYCLE COSTS:

Decisions to commit funding are made throughout the life of a program. The elements of life-cycle cost provide natural milestones for this decision process.

The life-cycle of a program begins with the identification of a mission requirement and ends with the disposal of the product when no longer needed. All phases of the program contribute to the life-cycle cost and must be considered when presenting an estimate. Failure to do so may well impact the future budgets at NASA for years to come. The impact of this failure is currently illustrated in the Department Of Energy (DOE) budgets due to the cost of the Superfund Sites.

For purposes of cost estimating, life-cycle costs are normally divided into four elements: Research and Development, Investment Costs, Operation and Support Costs and Disposal Costs. The figure below illustrates the program life cycle and shows how the various elements relate to the phases of a projects life-cycle cost. Note that actual programs may deviate from this generic pattern.



The following elements summarize the primary cost categories with each life-cycle phase:

- **Research and Development:** Consists of costs incurred from program initiation at Concept Demonstration and Approval (Milestone 1) through the Engineering and/or Manufacturing Development Phase. Includes cost of feasibility studies; modeling; trade-off analysis; engineering design; development, fabrication, assembly and test of prototype hardware and software; project tests and evaluation; project-specific support equipment and documentation.
- **Investment:** Consists of costs incurred during the Production and Deployment Phase (from Milestone 3 through completion of deployment). Encompasses costs associated with producing, procuring and deploying the primary hardware and directly associated hardware and activities; project specific support equipment, training, spares and data.
- **Operation and Support:** Includes all costs of operating, maintaining and supporting a fielded project. Encompasses costs for personnel; consumable and repairable materials; maintenance; facilities and sustaining investment. This phase overlaps with the Production and Deployment Phase, and may share costs. O&S costs are incurred in preparation for and after fielding and continue through the end of the project's useful life.
- **Disposal:** Captures costs associated with deactivating or disposing of a project at the end of its useful life. These costs represent only a small fraction of the life-cycle costs and are excluded from most analyses, unless required by law for disposal of toxins or other materials requiring special handling.[1]

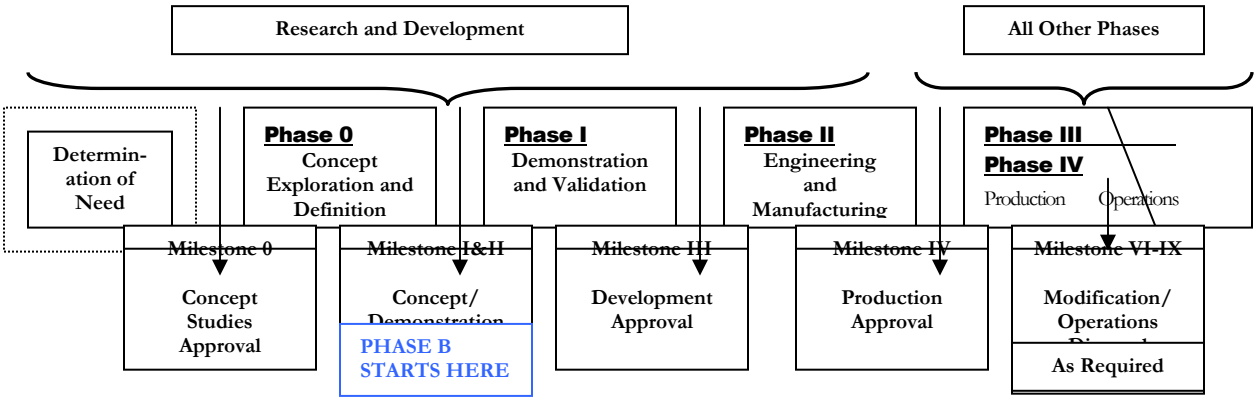
MILESTONES AND DECISION POINTS:

Life-cycle costs lends itself to nine major milestones and several major decision points to enable the Decision Authority to make intelligent choices concerning the allocations of funds, resources and facilities.

Research and Development: 5 Milestones (need determination, concepts and studies, demonstration, development, and production approval)
Production and Deployment: 2 Milestone (modifcations/descope, operations approval)
Operations and Support: 2 Milestones (increase/decrease scope, disposal approval)
Disposal 0 Milestones

Within each milestone one or more decision points should be assigned to ensure progress is beneficial and cost effective. This will provide a valuable method of controlling costs, ensuring objectives are met and defining the allocation of resources.

The following illustrates the major decision points associated with each phase of a program:



LIFE-CYCLE COST FOR RESEARCH AND DEVELOPMENT:

By definition the majority of the dollars allocated by NASA are for research and development (R&D). The problems associated with integrating R&D into life-cycle costing must be overcome if we are to meet the challenges put forth in The President's Management Agenda.

[1] Paraphrased/edited. Concept from DoDI 5000.2, 2/23/91 part 13

The mechanics of identifying, tracking and integrating the costs associated with R&D into the life-cycle cost of a mission is very clear when there is a Congressional mandate to field a mission such as the Space Shuttle. However, the majority of NASA funds support investigative fieldwork, which may support one or several as yet unidentified future missions or none at all. For these reasons, the following discussion puts forth a proposal to cost R&D as a life cycle within its own phase. When the R&D costs are tracked and recorded in this manner, the costs associated will be readily available for identification to the life cycle cost of future missions as necessary.

As illustrated above, the R&D portion of the life-cycle costs may be divided into three phases; Concept Exploration & Definition, Demonstration and Validation and Engineering/Manufacturing Development. By assigning milestones to each of the phases, estimated costs associated may be developed tracked and reported for the purposes of decision making. Each milestone must have a definite, scheduled occurrence in time, signaling the completion of the activity and/or signaling the start of a new activity.

Milestone 0: Concept Study Approval

This milestone marks the Decision Authority's approval to commission one or more alternative concepts or studies to support a present or future requirement.

Phase 0: Concept Exploration and Definition Approval:

The purpose of this phase is to explore alternatives that may satisfy a current or future need. Cost and effectivity analyses are prepared for review at Milestone I. A proposed strategy is developed for the most promising concept(s). An initial cost estimate, schedule and performance objectives are defined.

Milestone I: Concept Demonstration Approval:

At this milestone, the Decision Authority assesses the results of the Phase 0 studies, evaluating the relative costs against the likelihood of success and Agency needs. If approved, a concept baseline is established, defining cost, schedule and performance objectives. The baseline may also define restraints within which cost, schedule and performance trade-offs will be allowed.

Phase I: Demonstration/Validation:

The objective of this phase is to determine that technologies and design approaches are understood and attainable. Cost, schedule and performance trade-offs are made within defined restraints. A development baseline is proposed based upon the analysis and information required to support a Milestone II decision.

Milestone II: Development Approval:

The objective of this milestone is to determine if the results from Phase I warrant a concept's continued funding. The Decision Authority again assesses the concept's affordability, likelihood of success and Agency needs. If approved, a development baseline is refined for cost, schedule and performance objectives.

Phase II: Engineering or Manufacturing Development:

The objective of this phase is to render the preferred design or concept, developed in Phase I, into a working model on which tests can be performed and replicated. Configurations controls are established, resources are committed commensurate with risk, and the cost estimates are refined (again!)

THE BASELINE:

The President's Management Agenda uses the term *Performance Management* throughout, defining initiatives and outcomes.

> "To provide a greater focus on performance, the Administration plans to formally integrate performance review with budget decisions. This integration is designed to begin to produce ***performance-based budgets*** starting with the 2003 Budget submission."
>
> (emphasis added)

Definition: Performance Measurement Baseline (PMB): The time-phased budget plan against which project performance is measured. It is formed by the budgets assigned to scheduled cost accounts and the applicable indirect budgets.[2]

Development of the baseline is dependant upon a realistic assessment of the technical and resource requirements (including indirect budgets to fulfill full cost initiatives) to meet each milestone, the scheduling of those tasks and ascertaining the costs associated therewith. R&D traditionally has shied away from this type of scrutiny because it was difficult to accomplish. NASA no longer has a choice. We must place R&D efforts on a performance measurement baseline to meet the objectives set forth for us. The question is, how do we accomplish this in a short time without extensive training of scientists who do not want to be bothered?

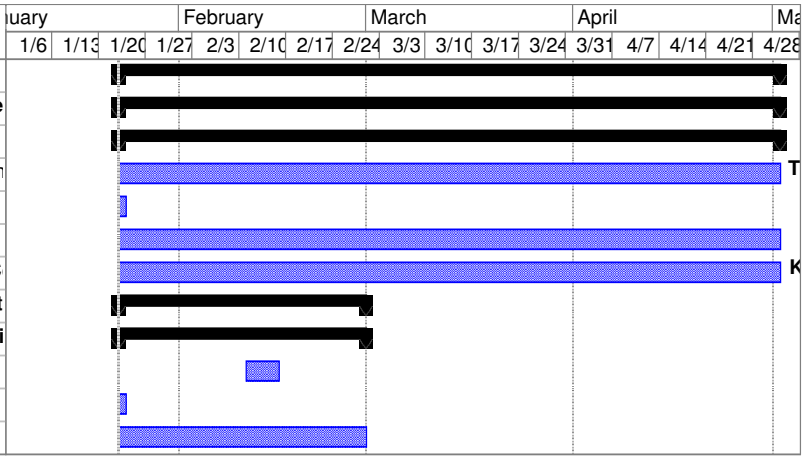
A RECOMMENDED TEMPLATE:

The Cost Analysis Data Requirement (CADRe) in Appendix A is a recommended format for project information necessary to perform an independent cost analysis. This format encompasses information necessary to perform a cost analysis for any type of project, therefore, not all informational aspects are applicable to all projects.

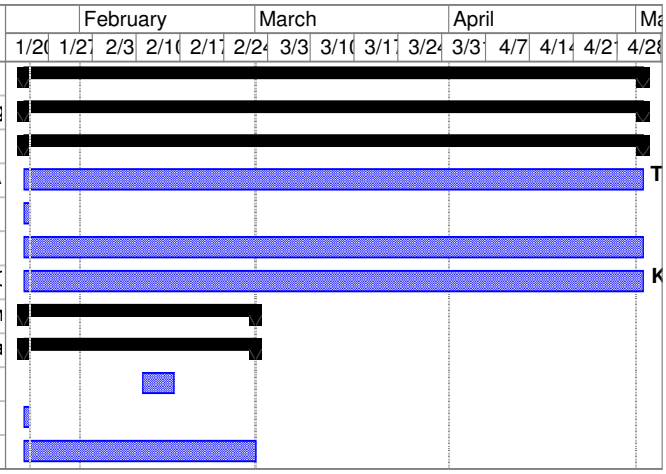
In an Excel ™ spreadsheet or a Microsoft Project ™ template, the estimator will be able to provide a time-phased plan for each task that will serve as the baseline. The following examples are from Microsoft Project.

[2] Cost/Schedule Control Projects Criteria, Flemming, 1992, p.547

ID	Fixed C	WBS	Task Name
1	**$0.0**	**1**	**Project Alpha**
2	**$0.0**	**1.**	**Project Manage**
3	**$0.0**	**1.1.**	**Manager**
4	$0.0	1.1.1	Budget An
5	$500.	1.1.1	Supplies
6	$200.	1.1.1	Odin
7	$0.0	1.1.1	Support C
8	**$0.0**	**1.1**	**Concept Definit**
9	**$0.0**	**1.2.**	**Concept Vali**
10	$1,000	1.2.1	Travel
11	$500.	1.2.1	Supplies
12	$200.	1.2.1	Odin



ID	Baseline C	Fixed C	WBS	Task Name
1	**$115,04**	**$0.0**	**1**	**Project Alpha**
2	**$105,78**	**$0.0**	**1.**	**Project Manag**
3	**$105,78**	**$0.0**	**1.1**	**Manager**
4	$19,88	$0.0	1.1.	Budget A
5	$500	$500	1.1.	Supplies
6	$200	$200	1.1.	Odin
7	$56,80	$0.0	1.1.	Support C
8	**$9,26(**	**$0.0**	**1.**	**Concept Defin**
9	**$9,26(**	**$0.0**	**1.2**	**Concept Va**
10	$1,00(	$1,00(	1.2.	Travel
11	$500	$500	1.2.	Supplies
12	$200	$200	1.2.	Odin



CONCLUSION:

Each milestone and phase establishes a gate for one or more Decision Authorities to determine the advisability of continued funding and activity. Each also requires a baseline containing cost, schedule and performance objectives. The baseline allows each to be tracked, recorded and preserved for future use, as applicable, to be added to life-cycle costs of future missions.

Further, this approach provides a documentation trail supporting the Decision Authority actions, meeting the following initiative:

"...OMB will work with agencies to select objectives for a few important programs, assess what programs do to achieve these objectives, how much that costs, and how effectiveness could be improved."

APPENDIX A

SAMPLE COST ANALYSIS
DATA REQUIREMENT

(CADRE)

TIME PHASED-LIFE CYCLE COST

ALTERNATIVE _____

Date: _____

Prepared by: _____ Phone # _____E-Mail:_____

Program/Project Name: _____

Estimated Period of Performance: _____

Program/Project Manager: _____Phone# _____E-mail _____

1.0 -- Project Overview

1.1 -- Project Characterization.

This section discusses the basic attributes of the project -- its configuration, the missions it will perform and threats it will counter, its relationship to other projects, and the major factors that will influence its cost. The presentation should be structured as follows:

1.1.1 Project Description. This paragraph provides a general description of the project, including the functions it will perform and key performance parameters. The parameters should be those most often used by cost estimators to predict project cost. Examples of key project characteristics and performance parameters are provided in enclosure 1. A diagram or picture of the end item, with the major parts and subprojects appropriately labeled, should be included, if applicable.

1.1.2 Project Functional Relationships. This paragraph describes the "top-level" functional and physical relationships among the projects within the program as well as the project's relationship to other projects or programs, as applicable.

1.1.3 Project Work Breakdown Structure: This section identifies the WBS for the project (e.g., program management, hardware, software, testing). If this project is part of a program, the

top level WBS for the program should be included, indicating the project's relationship to the program.

1.1.4 Government-Furnished Equipment and Property. This paragraph identifies the property that will be furnished by the Government and included in the life-cycle cost estimates for the project. Any Government-furnished commercial off-the-shelf (COTS) software should be addressed in the discussion. Where Government-furnished equipment or property is common to other program/projects, the text should identify how the costs will be accounted for (e.g., shared, costed to one or more projects).

1.2 -- Project Characteristics.

This section provides a technical description of the hardware, software, and human characteristics of the project. It is divided into the following sub-elements:

1.2.1 Technical and Physical Description. This set of paragraphs describes the physical design parameters of the project. A separate discussion is provided for each equipment (hardware and software) work breakdown structure (WBS) item. Physical design parameters should include performance, operational (including project design life), and material (weight and material composition) characteristics. The planned sequence of changes in weight, performance, or operational characteristics that are expected to occur or have historically occurred as the program progresses through the acquisition and operating phases -- demonstration and validation (DEM/VAL), engineering and manufacturing development (EMD), production, and operation and support (O&S) -- should be noted here.

1.2.1. *x* (..*x*..) Subproject Description. This series of paragraphs (repeated for each subproject) describes the major equipment (hardware/software) WBS components of the project. The discussion should identify which items are off-the-shelf. The technical and risk issues associated with development and production of individual subprojects also must be addressed.

1.2.1.*x*.1 Functional and Performance Description. This subparagraph identifies the function(s) the (..x..) subproject is to perform. In addition, it describes the associated performance characteristics and lists any firmware to be developed for data processing equipment.

1.2.1.*x*.2 Environmental Conditions. This subparagraph identifies the environmental conditions expected to be encountered during development, production, transportation, storage, and operation of the subproject. It also identifies any hazardous, toxic, or radiological materials that may be encountered or generated during the subproject's development, manufacture, transportation, storage, operation, and disposal. The quantities of each hazardous material used or generated over the subproject's lifetime should be estimated based on the most current operations and maintenance concepts. The discussion should also describe the evaluation methodology for environmentally acceptable alternatives as well as the rationale for selection of alternatives. Finally, the alternatives considered, and reasons for rejection, must be identified.

1.2.1.*x*.3 Material, Processes, and Parts. This subparagraph describes the materials and processes entailed in the development and fabrication of the subproject. The discussion should identify the respective amount of each material to be used (e.g., aluminum, steel, etc.). In

addition, any standard or commercial parts, or parts for which qualified products lists have been established, should be identified.

1.2.1.*x*.4 Workmanship. This subparagraph describes any specific workmanship-related manufacturing or production techniques pertaining to the subproject.

1.2.1.*x*.5 Commonality. Equipment that is analogous or interchangeable among sub-projects should be identified here. Commonality with subprojects of other projects, or with variants of the basic project, should be identified. Breakouts, by weight, of common and project-specific components should be provided, if applicable.

1.2.2 Software Description. This paragraph describes the software resources associated with the project. It should distinguish among operational, application, and support software and identify which items must be developed and which can be acquired off-the-shelf. The paragraph applies to all projects that use computer and software resources. Information should be attached to the CADRE submission providing information on the factors that will influence software development and maintenance costs. Information can be provided in any format, such as a matrix or table. Additionally, this information should be tailored to satisfy specific software model requirements.

1.2.2.*x* (..*x*..) Software Sub-elements. This set of paragraphs (repeated for each software sub-element) describes the design and intended uses of project software.

1.2.2.*x*.1 Host Computer Hardware Description. This subparagraph describes the host computer project on which the software sub-element will be operating. This host project should be readily identifiable in the WBS given in paragraph 1.1.3., above.

1.2.2.*x*.2 Programming Description. This subparagraph identifies programming requirements that will influence the development and cost of the software sub-element. The discussion should address the programming language and programming support environment (including standard tools and modern programming practices) and the compiler(s) and/or assembler(s) to be used.

1.2.2.*x*.3 Design and Coding Constraints. This subparagraph describes the design and coding constraints under which the software will be developed (i.e., protocols, standards, etc.).

1.2.2.*x*.4 Commonality. This subparagraph identifies software that is analogous or interchangeable among sub-elements.

1.2.3 Human Performance Engineering. This paragraph identifies any special or unique human performance and engineering characteristics (i.e., constraints on allocation of functions to personnel and communication, and personnel and equipment interactions).

1.2.4 Project Safety. This identifies any special or unique project safety considerations (e.g., "fail safe" design, automatic safety, explosive safety needs, etc.).

1.2.5 Project Survivability. This paragraph discusses the survivability capabilities and features of the project. It describes the environments in which the project will be expected to operate, and identifies any unique materials incorporated in the project's design that contribute to its survivability.

1.3 -- Project Quality Factors.

This section identifies key project quality characteristics.

1.3.1 Reliability. This paragraph defines project reliability goals in quantitative terms, and defines the conditions under which the goals are to be met.

1.3.2 Maintainability. This paragraph focuses on maintainability characteristics. It describes the planned maintenance and support concept in the following quantitative terms:

a. Project maintenance man-hours per operating hour, maintenance man-hours per operating hour by major component part of the project, operational ready rate, and frequency of preventative maintenance;

b. Maintenance man-hours per overhaul;

c. Project mean and maximum down time, reaction time, turnaround time, mean and maximum time to repair, and mean time between maintenance actions;

d. Number of people required and the associated skill levels at the unit maintenance level;

e. Maximum effort required to locate and fix a failure; and

f. Specialized support equipment requirements.

1.3.3 Availability. This paragraph defines, in quantitative terms, the availability goals for specific missions of the project. It should identify the percentage of the projects expected to be operable both at the start of a mission and at unspecified (random) points in time.

1.3.4 Portability and Transportability. This paragraph discusses the portability and transportability features of the project (equipment and software) and describes how they affect employment, deployment, and logistic support requirements. Any subprojects whose operational or functional characteristics make them unsuitable for transportation by normal methods should be identified.

1.3.5 Additional Quality Factors. This paragraph describes any quality features not addressed in the preceding paragraphs (i.e., interoperability, integrity, and efficiency features of the project).

1.4 -- Embedded Security.

If there is embedded security in the project, the software and hardware requirements should be fully identified in paragraph 1.1.3, above, and described here.

1.5 -- Predecessor and/or Reference Project.

This section describes the predecessor and/or reference project. A predecessor and/or reference project is a currently operational or pre-existing project with a mission similar to that of the proposed project. It is often the project being replaced or augmented by the new acquisition. The discussion should identify key project-level characteristics of both the predecessor and/or reference project and the new or proposed project. Any problems associated with the predecessor project should be discussed, along with any significant differences between the predecessor project and the proposed project. The narrative should also describe how the predecessor project is to be replaced with the proposed project (e.g., one-for-one replacements, etc.), as applicable. Information on the planned disposition of the replaced projects should be provided so that disposal costs and benefits can be considered in the cost estimate. The above information should also be provided on analogous subproject and components that can be used to scope or estimate the new project.

2.0 -- Risk.

This section identifies the program manager's assessment of the program and the measures being taken or planned to reduce those risks. Relevant sources of risk include: design concept, technology development, test requirements, schedule, acquisition strategy, funding availability, contract stability, or any other aspect that might cause a significant deviation from the planned program. Any related external technology programs (planned or on-going) should be identified, their potential contribution to the program described, and their funding prospects and potential for success assessed. This section should identify these risks for each acquisition phase (R&D, DEM/VAL, EMD, production and deployment, and O&S).

3.0 -- Project Operational Concept.

3.1 -- Security.

This paragraph describes the project's physical security, information security, and operations security features. Hardware and software aspects of communications and computer security should also be addressed.

3.2 -- Logistics.

This paragraph summarizes key elements of the Integrated Logistics Support Plan (ILSP). The information is divided into the following subparagraphs:

3.2.1 Support Concept. These subparagraphs describe the hardware and software support concepts.

3.2.1.1 Hardware Support Concept. This subparagraph describes the hardware support concept, taking into account:

a. Service (organic) versus contractor support requirements.

b. Interim support (fielding) plans.

c. Scheduled maintenance intervals and major overhaul points.

d. Maintenance levels and repair responsibilities.

e. Repair versus replacement criteria.

f. Standard support equipment to be used.

g. Specialized repair activities (SRAs).

h. Hardness assurance, maintenance, and surveillance plans for projects with critical survivability characteristics (e.g., hardness to high altitude electromagnetic pulse).

i. Other requirements not previously mentioned.

3.2.1.2 Software Support Concept. This subparagraph describes the software support concept, including methods planned for upgrades and technology insertions. The discussion should also address post-development software support requirements.

3.3.3 Training. This paragraph summarizes the training plans for project operators, maintenance personnel, and support personnel.

a. The training that needs to be accomplished and the organizations that will conduct the training;

b. The number of projects that must be acquired solely for training purposes;

c. The need for auxiliary training devices, the skills to be developed by those devices, and computer simulation requirements;

d. Training times and locations;

e. Source materials and other training aids;

f. Other training requirements not previously mentioned.

4.0 -- Quantity Requirements.

This section consists of a matrix identifying the quantities of the project to be developed, tested, produced, and deployed by acquisition phase and year. The quantities identified should be sufficient for maintenance and readiness floats as well as for peacetime attrition requirements.

For complete project end-items such as whole engines, the quantities allocated for initial spares and replacement spares should be separately identified.

5.0 -- Project Manpower Requirements.

This section describes the manpower needed to support the project.

6.0 -- Project Activity Rates.

This section defines the activity rates (e.g., number of operating hours per year, flight hours per month or year, operating shifts per day, etc.) for each project or subproject.

7.0 -- Project Milestone Schedule.

This section describes the acquisition schedule for the project. Both hardware and software schedules should be discussed. A Gantt chart showing the major milestones of the program by phase (e.g., design reviews, first flights, significant test events, unique milestone reviews, initial deployment data, and final operational capability) should be provided. A more detailed program master schedule should be included as a reference or appendix. Specific element schedules, if known, should be presented with the descriptions of those elements.

8.0 -- Acquisition Plan and/or Strategy.

This section describes the acquisition plan for the project. It addresses the following:

8.1 -- Contractors.

This paragraph identifies the number of prime contractors expected to compete during each acquisition phase. The specific contractors and subcontractors involved in each phase should be identified, if known. If this information is source selection sensitive, special labeling of the overall CADRE may be required.

8.2 -- Contract Type.

This paragraph describes the type of contracts to be awarded in each phase of the program. The status of any existing contracts should be discussed.

9.0 -- Project Development Plan.

9.1 -- Development Phases.

9.2 -- Development Test and Evaluation.

This paragraph describes all testing to be accomplished during the program. The number, type, location, and expected duration of tests (for both hardware and software) should be identified, along with the organizations that will conduct the test programs. Examples of tests to include are contractor flight tests, static and fatigue testing, logistic testing to evaluate the achievement of supportability goals, etc. Contractor and government- conducted tests should be separately identified.

9.3 -- Operational Test and Evaluation.

This paragraph describes all testing to be conducted by agencies other than NASA to assess the project's utility, operational effectiveness, operational suitability, logistics supportability, etc. The number, type, location, and expected duration of tests (for both hardware and software) should be identified, along with organizations that will conduct the test programs.

10.0 -- Element Facilities Requirements.

10.1 -- Test Facilities.

This paragraph describes the type and number of hardware and software test facilities (both contractor and government owed) required during all phases of program acquisition. Separately identify those funded as part of the acquisition prime contract, those separately funded by the program office (if applicable), and those provided by other activities -- such as a government test organization or facility. Existing facilities that can be modified and/or utilized should be noted..

10.2 -- Operational Support Facilities.

This paragraph describes the type and number of hardware and software facilities required for project deployment, operation and support (including training, personnel, depot maintenance, etc.). Existing facilities that can be modified and/or utilized should be noted. The discussion should describe the size and design characteristics of the respective facilities.

10.3 -- Facilities Commonality.

This paragraph identifies the facilities and equipment that are common to this and other programs. The discussion should specify how these items will be accounted for in the cost estimates.

11.0 -- Track to Prior CADRE.

This section summarizes changes from the previous CADRE. The discussion should address changes in project design and program schedule, as well as in program direction. This section is applicable to projects which have determined that major changes, such as de-scope of requirements, is necessary.

12.0 -- Contractor Cost Data Reporting Plan.

This section contains a copy of the CCDR Plan approved for the program. If the Plan has not yet been approved, or is waiting approval, include a copy of the proposed CCDR Plan.

Enclosure 1

Examples of Key Project Characteristics and Performance Parameters

***Aircraft*:** Airframe unit weight (AUW); breakdown of AUW by material type; empty weight; structure weight; length; wingspan; wing area; wing loading; combat weight; maximum gross weight; payload weight; internal fuel capacity; useful load; maximum speed (knots at SL/maximum altitude); combat ceiling; combat speed; wetted area

***Engines*:** Maximum thrust at sea level; specific fuel consumption; dry weight; turbine inlet temperature (degrees Rankine) at maximum value and maximum continuous value; maximum airflow

***Data Automation/ADPE*:** Type (mainframe, mini, micro); processor (MIPS, MPLOPS, MOPS, SPECMARKS); memory (size in megabytes); architecture (monolithic, distributed)

Electronics: Weight by Type of Project:

Type Project	***Performance Measures***	***Technology***	***Other***
Radar	Output Power Range Resolution Classification Capable Frequency Number Phase Shifters	MIMIC TWT VHSIC Stealth SOS, etc. Software	Phased Array Type Scan Installation Reliability Waveform Quantity Number of Elements
Communications	Frequency Power Number Channels Interoperability LPI Range/LOS/NLOS	MIMIC Antenna Type SOS, etc. Stealth Software	Tactical/Strategic Secure Anti Jam User Community Data/Voice
Satellite	Quantity Orbit Number of Users Power Waveform	Size/Weight Launch Vehicle Processors Bus Software	Purpose Coverage Design Life

[i] Prepared for Lewis Braxton, CFO Ames research Center NASA by Charlotte diCenzo